# Knowledge Superiority Parameter – a Metric for Network Centric Warfare (NCW)?

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# The Problem?

– NCW concepts include the primacy of information and its exploitation using technology.

– Evaluating the military worth of knowledge derived from information is, however, a major challenge for the international OR community.
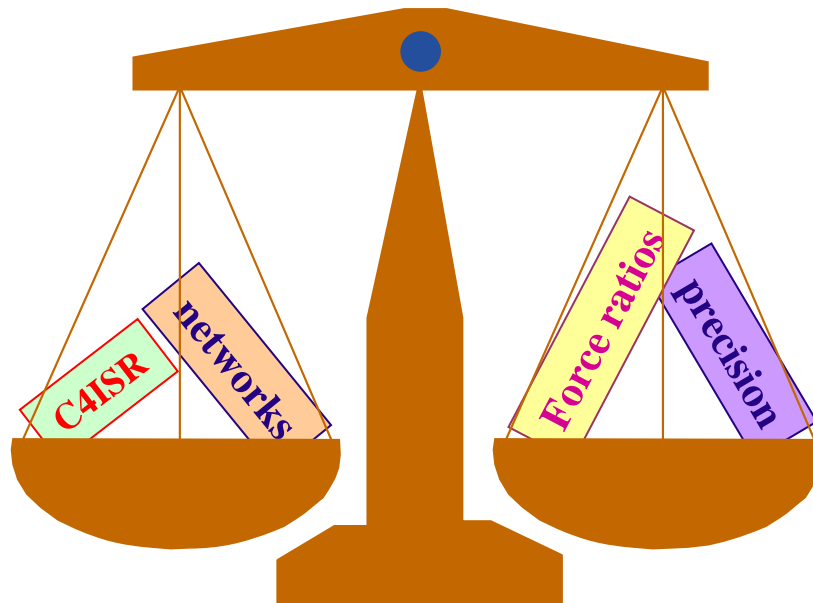
# Lanchester Equations Reformulated

In 2001 Darilek et al introduced knowledge-enhanced Lanchester equations in an effort to gain insight into the potential contribution of knowledge to combat operations. They:

- Regarded knowledge as taking account of both the quality and value of information.

- Introduced a knowledge superiority parameter, $\Gamma$, determined from the maximum number of enemy a unit encounters in a combat cycle,

$$\Gamma \ = \ \frac{K_B}{K_R}$$

where $K_B$ is the knowledge blue forces have of red forces and $K_R$ is the knowledge red forces have of blue forces. These knowledge factors represent the knowledge available from external sources.

# The NCW Case

- The question arises as to whether the linear or square Lanchester law applies for NCW.

- Darilek et al. noted that if the number of encounters is directly proportional to a side's external knowledge then for a blue victory:

$$\frac{M}{N}\Gamma > \frac{R}{B} \qquad \text{where} \quad \Gamma = \frac{K_B}{K_R}$$

  and M and N are the effectiveness of the Blue and Red forces respectively.

- We contend that a NCW approach enables encounters through the external knowledge that is obtained and hence this condition applies.

# Agent-Based Distillations (ABDs)

– Similar to a cellular automata model.

– Agents are described by a number of variables.

– Agents behaviour is determined by these.

– Results of behaviours dependant on agents and environment.
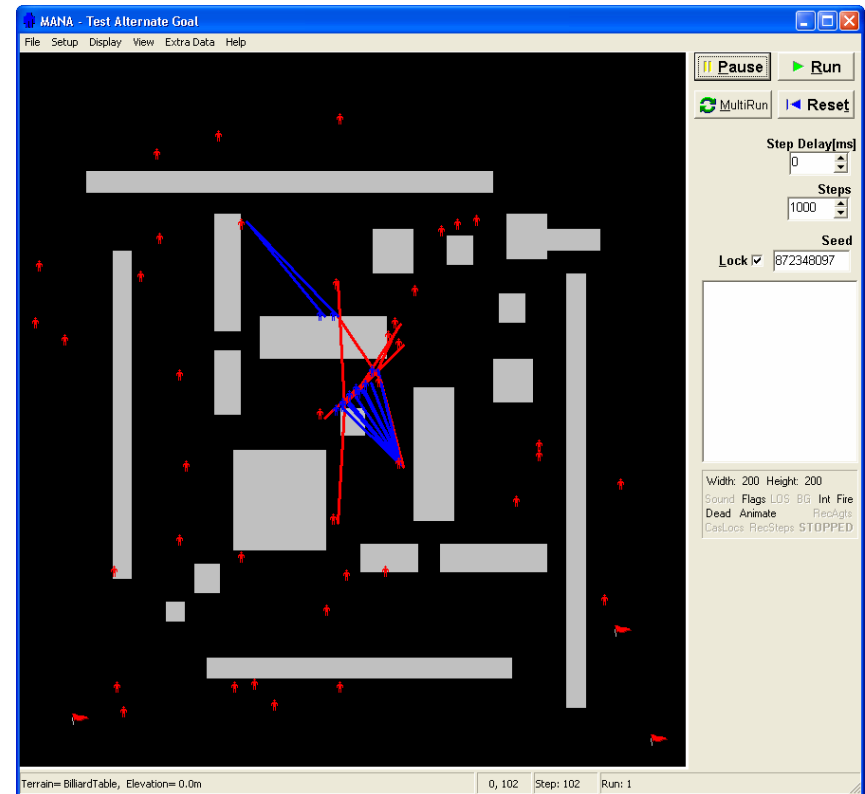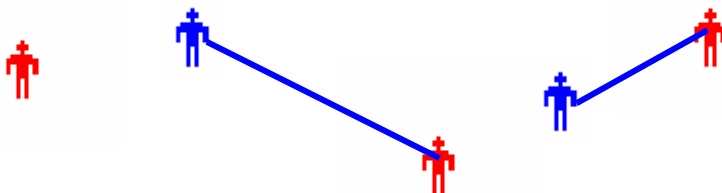
# Linking of Lanchester Equations with ABDs

- – 'Hook and crook' approach to linking parameters such as SSKP to the theoretical Knowledge Superiority Parameter (KSP) through force-exchange ratios.

- – ABDs provide a stochastic approach to determining force-exchange ratios for various sizes of forces and SSKP.

- – Reformulated Lanchester equations link SSKP to KSP through force-exchange ratio.

$$\frac{M}{N}\Gamma > \frac{R}{B}$$

# The MANA Scenario

- 'Lanchester-like' modelling, i.e.:

  - no terrain;

  - random movement;

  - randomly distributed.

- Opposing forces given same abilities (but to varying degrees).

- Sensitivity to force size was examined.

- Broad 'scoping' runs followed by detailed grid pattern of:

  - 210 runs (7 SSKPs, 15 force ratios),

  - each with 500 Monte Carlo simulations.

- Winner was the side that increased its force ratio.

# Results from MANA



MANA Data and Fit(*):
Probability Blue Win vs Force Ratio (B/R)
for various SSKP ratios (B/R)
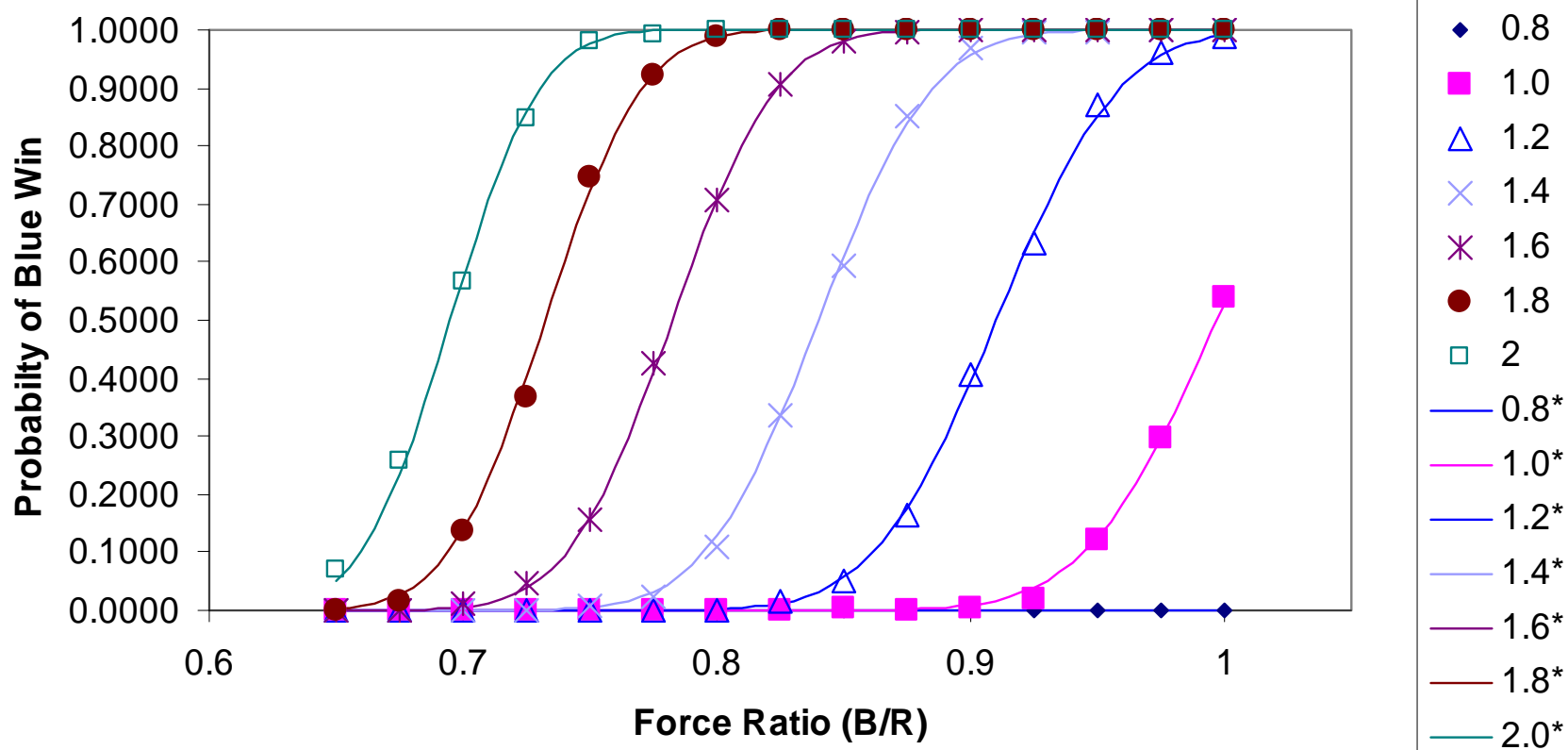
# Knowledge Superiority Parameter versus SSKP
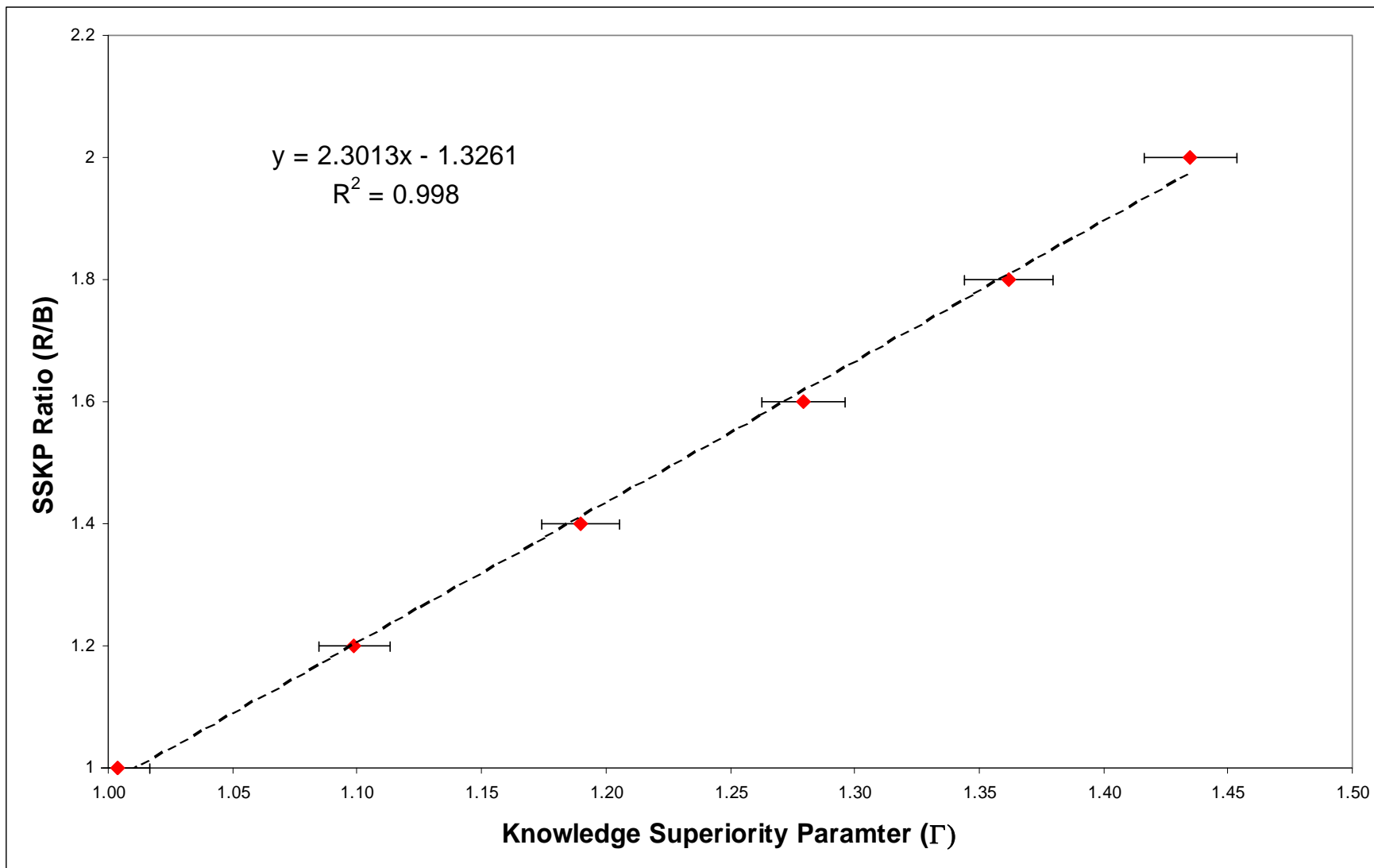
# In Summary

- Strengths
  - Establishes relationship between $\Gamma$ and SSKP.
  - Simple approach where results can be readily obtained.

- Weaknesses
  - Relationship between $\Gamma$ and other C4ISR measures is unclear.
  - Meaning of in terms of situational awareness.

- Future Work
  - Exploration of $\Gamma$ in terms of C4ISR metrics.
  - Linking of $\Gamma$ to other measures of weapons effectiveness.